UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

EBS 209/3 – Mineralogy
[Mineralogi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains **TWO** questions from **PART A** and **FIVE** questions from **PART B**.
*[Kertas soalan ini mengandungi **DUA** soalan dari **BAHAGIAN A** dan **LIMA** soalan dari **BAHAGIAN B**.]*

Instruction: Answer **ALL** questions from **PART A** and **THREE** questions from **PART B**. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **SEMUA** soalan dari **BAHAGIAN A** dan **TIGA** soalan dari **BAHAGIAN B**. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

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PART A: Answer all of the following questions.
BAHAGIAN A: Jawab semua soalan berikut.

1. Answer all the following questions:
Jawab semua soalan berikut:

[a] (i) Given Miller indices and ρ and ϕ angles for crystal faces that, in combination, intersect all crystallographic axes, calculate the axial ratios of the mineral.

Diberikan indek Miller dan sudut-sudut ρ dan ϕ bagi kombinasi muka-muka kristal yang memotong kesemua paksi-paksi hablur. Kirakan nisbah paksi bagi mineral tersebut.

Faces *(muka)*	ρ	ϕ
(110)	90°	45°
(011)	60°	0°

(ii) What are the Miller Index of the following faces of a forms that having the following Weiss parameters?

Apakah nilai indek Miller bagi sebuah bentuk yang mempunyai parameter Weiss seperti berikut?

(a) 6a :1/4b : 3c minus (b) 1/2a (minus) : 1/4b : infinity c

[b] (i) Briefly discuss what do polymorphism means in mineralogy? State the name of the mineral class represented by the anion or complex anion below.

Secara ringkas bincangkan maksud polimerfisma dalam mineralogi? Nyata dan namakan kelas mineral yang diwakili oleh anion dan kompleks anion berikut.

(i) $(VO_4)^{-3}$ (ii) $(PO_4)^{-3}$ (iii) $(CO_3)^{-3}$

(iv) $(MoO_4)^{-2}$ (v) $(OH)^{-1}$

(ii) Silicate minerals is the most abundance minerals and has been classified in accordance the structures how atoms of silicon and oxygen packed together, i.e. tetrahedral is shared to form silicate structures like island or ring. Given below formula of some silicate minerals, and please determine it silicate group.

Mineral silikat adalah mineral yang terbanyak dan diklasifikasikan menurut struktur-struktur bagaimana atom-atom silikon dan oksigen digabungkan, iaitu tetrahedral dikongsikan bagi membentuk struktur silikat seperti berbentuk pulau dan cincin. Diberikan di bawah formula sekumpulan mineral silikat. Tentukan jenis kumpulan silikatnya.

(i) $Ca_2(Fe^{+3},Al)Al_2(SiO_4)(Si_2O_7)(OH)$

(ii) $Be_3Al_2Si_6O_{18}$

(iii) $Ca(Mg,Fe)Si_2O_6$

(iv) $K(Mg,Fe)_3(AlSi_3)O_{10}(OH)_2$

[c] Calculate the weight percent of each element (cation) oxides for the empirical formula of the mineral below.

Kirakan peratus berat setiap elemen (kation) oksida bagi formula empirikal mineral di bawah.

$MgAl_2O_4$ (Spinel) and $K(AlSi_3O_8)$ (Atomic weight/Berat atom Mg : 24.31, Al : 26.98; K :39.10).

Determine the valencey of the following element listed as "X" in each formula:

Tentukan valensi bagi unsur-unsur yang tidankan sebagai 'X" dalam setiap formula di bawah:

(i) $Pb(\mathbf{X}O_4)$ and / *dan* (ii) $Li\mathbf{X}(Si_2O_6)$

(20 marks/*markah*)

2. Answer all the following questions:
Jawab semua soalan berikut:

[a] Define tenacity in mineral. State and describes different classes of tenacity for metallic minerals together with an appropriate example.
Define S.G. and how S.G. of mineral crystals is determined, and what are the factors that governed this S.G of mineral.

Takrifkan kekukuhan bagi mineral. Nyata dan terangkan kelas-kelas kekuhuan berbeza bagi mineral-mineral logam beserta contoh bersesuaian.
Takrifkan S.G. dan bagaimana S.G. hablur mineral ditentukan, dan apakah faktor yang mengawal S.G. mineral?

[b] X-ray Diffiraction (XRD) technique is widely used to study the structure of mineral crystal. By using appropriate diagram, please show and derive the Bragg's Law. A different pattern of a mineral is obtained by using x-rays with wavelength λ = 0.709 Å. The second-order Bragg diffraction from the parallel faces of the cubic unit cells is observed at the angle 2θ = 20.2°. Calculate the lattice parameter *a*.
Husmanite ($MnMn_2O_4$) has tetragonal cell edges a = 5.76 Å , c = 9.44; Z = 4. Calculate 2θ for CuK_α radiation = 1.5405A for the following direction, (101) and (021).

Teknik pembelauan Sinar X digunakan secara meluas untuk mengkaji struktur hablur mineral. Dengan rajah bersesuaian sila tunjuk dan terbitkan hukum Bragg. Satu corak mineral telah diperolehi menggunakan X-ray dengan λ = 0.709 Å. Order kedua belauan Bragg daripada muka-muka selari sel-sel unit kubus telah diperhatikan pada sudut 20.2°. Kirakan parameter kekisi, a.
Husmanit ($MnMn_2O_4$) mempunyai sisi-sisi sel tetragonal a = 5.76 Å , c = 9.44; Z = 4. Kirakan sudut 2θ untuk radiasi CuK_α = 1.5405 Å dalam arah-arah (101) and (021) berikut.

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[c] The mineral pyrope is the magnesian end-member of the garnets. It has the chemical formula $Mg_3Al_2Si_3O_{12}$. Express the weight percents of the appropriate oxides. Meanwhile pyroxene enstatite ($MgSiO_3$) occurs in three different polymorphs. One of them is clinoenstatite (monoclinic) with cell edges a = 9.605 Å, b = 8.813 and c = 5.166, β= 108.46°. Calculate the density of this mineral.
Avogadro no. $6.022 \times 10^{+23}$.

Mineral pirop adalah ahli-akhir magnesia garnet yang mempunyai formula kimia $Mg_3Al_2Si_3O_{12}$. *Nyatakan peratus berat oksidanya. Manakala enstatit* ($MgSiO_3$) *terjadi dalam tiga polimorf berbeza. Salah satunya adalah klinoenstatit (monoklinik) dengan sisi-sisi unit.* a = 9.605 Å, b = 8.813 and c = 5.166, β= 108.46°. *Kirakan ketumpatan mineral ini.*
No. Avogadro ialah $6.022 \times 10^{+23}$.

(20 marks/*markah*)

PART B: Answer any three (3) of the following questions
BAHAGIAN B: Jawab tiga (3) soalan berikut.

3. [a] Briefly discuss the composition of the earth crust, and factors or geological environments that governs the process of minerals formation.

Secara ringkas terangkan mengenai komposisi kerak bumi serta faktor-faktor atau persekitaran geologi yang mengekang proses pembentukan mineral.

[b] State the number of atoms of each element associated with the unit cell of the mineral with the empirical formula, $Cu_3SO_4(OH)_4$ $Z = 4$.

Nyatakan bilangan atom-atom bagi setiap unsur yang berasiosasi dengan unit sel mineral yang berformula empirikal $Cu_3SO_4(OH)_4$ $Z = 4$.

(20 marks/*markah*)

4. [a] What is electro neutrality? Determine and write the electro neutrality components for mineral Titanite ($CaTiSiO_5$) Perovskite ($CaTiO_3$) and Fosterite (Mg_2SiO_4).

Apakah itu elektro kenutralan? Tentu dan tuliskan komponen-komponen kenutralan bagi Titanit ($CaTiSiO_5$), *Perovskite* ($CaTiO_3$) *dan Fosterite* (Mg_2SiO_4).

[b] Define and discuss different categories of luster in mineral (metallic and non-metallic), and its relationship to mineral's refractive index.

Takrif dan bincangkan kategori berbeza kilauan bagi mineral (logam dan bukan logam), serta hubungannya dengan indek biasan mineral.

(20 marks/*markah*)

5. [a] Determine the formulas and identity of these minerals which possessed the following compositions:

Tentukan formula serta identiti mineral-mineral yang mempunyai komposisi seperti berikut:

(i) SiO2 : 51.5%, FeO : 30.8%, MgO : 17.7%

(ii) Mn : 63.2%, O : 36.8%

(iii) Fe : 72.4%, O : 27.6%

(iv) FeO : 32.0%, Cr_2O_3 : 68.0%;

[b] Discuss crystal habit?. Describe and Illustrate the appearances of the following crystal habits of *tabular, fibrous, dentretic* and *botryoidal*

Bincangkan apa itu habit hablur? Terang dan gambarkan rupabentuk habit-habit hablur, fiber, dentritik dan botroidal.

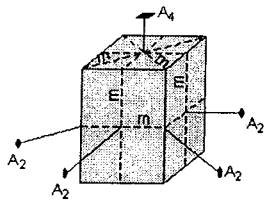
(20 marks/*markah*)

6. [a] Define minerals. Elaborates the meaning of "Homogeneous" and "Definite chemical composition".

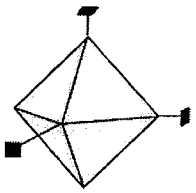
Takrif mineral. Perjelaskan maksud "kehormogenan" dan "komposisi kimia tertentu".

[b] Define Steno's law of constancy of interfacial angles. Also note down four basic of symmetries (elements and operation). Write down the symmetry contents, number of faces, the type of crystal forms and system for the given crystals

Takrif hukum steno mengenai ketetapan sudut antaramuka. Juga nyatakan empat simetri asas (unsur dan operasi). Tuliskan kandungan simetri, bilangan muka dan jenis bentuk hablur dan system bagi hablur yang diberikan di bawah.



(a)



(b)

(20 marks/*markah*)

7. [a] Although a crystal structure is an ordered arrangement of atoms on a lattice, as we have seen, the order may be different along different directions in the crystal. State and discuss types of v*ectorial properties* with appropriate examples.

Meskipun struktur hablur adalah suatu susunan teratur atom-atom pada kekisi seperti yang kita maklum, aturan ini mungkin berbeza sepanjang arah yang berlainan dalam hablur itu. Nyatakan jenis-jenis sifat vektor hablur dengan contoh-contoh bersesuaian.

[b] Note that the 32 crystal classes are divided into 6 crystal systems based on the uniques of theirs symmetry contents respectively. Should the triclinic system has only 1-fold or 1-fold rotoinversion axes, how about for the systems belongs to Monoclinic, isometri and monoclinic? Also shows theirs axial relationship, respectively.

Perhatian bahawa 32 kelas hablur adalah digolongkan kepada hanya 6 sistem hablur berasaskan kepada keunikan kandungan simetri masing-masing. Sekiranya sistem triklinik mempunyai hanya paksi-paksi lipatan atau 1-lipatan putaran-sonsangan, bagaimana pula bagi sistem-sistem monoklinik, isometrik dan monoklinik? Tunjukkan juga perhubungan paksi mereka masing-masing.

(20 marks/*markah*)

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